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ABSTRACT

This paper discusses organizational processes and memory in general and organizaticnal processes and adult age differences in memory in particular. The simplest analysis of memory is to divide the process into two parts: storage and retrieval. Studies show that the limitation of memory lies primarily in retrieval rather than storage. Organization represents a retrieval plan or rule to provide a set of cues. From this approach, there are at least two possible sources of adult age differences in retrieval processes: (1) differences in the quantity and quality of the information contained in the retrieval plan; and (2) differences in the availability of the retrieval plan at recall. Studies are presented illustrating both of these possibilities. (KJ/Author)

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Organization and Memory In Adulthood

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Recent years have witnessed an increasing emphasis on the concept of "cognitive organization" in accounting for what people learn and remember. This concept is really old wine in new wineskins, since there are a number of historical precursors (Katona, 1940; Thorndike, 1935). Nevertheless, there has been a modification of research directions, especially in the area of human memory. In this paper, I would like to discuss organizational processes and memory in general, and organizational processes and adult age differences in memory in particular.

Organization and Memory

First, let us consider organizational processes and memory in general. While data had been available previously, the importance of organization in information processing was clearly illustrated by Miller (1956 a; 1956 b). It had long been apparent that there are limitations on the capacity of the human organism for processing information. Miller (1956 a) pointed out that the limiting value of this capacity seemed to be a "magical number" of 7 ± 2. That is, evidence suggests that individuals do not recall more than about seven items from a list when tested for immediate memory, nor are they able to distinguish more than about seven alternatives of a unidimensional variable. However, since it is obvious that humans are able to process more than seven items of information, some mechanism must be instrumental in extending human memory and capacity for judgement. Briefly, Miller (1956 a; 1956 b) suggested

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that this mechanism consists of increasing the amount of information each item contains by organizing the input. This process of organization involves recoding the information into new and larger units which Miller referred to as chunks. Memory, then, consists of recall of a limited number of chunks, and retrieval of the contents of these chunks.

A formulation such as Miller's uses the concept of organization as the basis of human memory. However, as various writers have pointed out, the term "organization" often has clearer emotional than denotative meaning (Bower, 1970; Mandler, 1967). Basic to most definitions of cognitive organization, however, seem to be the notions of groups and relations (Bower, 1970). That is, psychological elements can be grouped together on the basis of common properties, or related to one another on the basis of rules.

Grouping and relating are basic cognitive processes that can be illustrated in the context of a number of tasks such as paired-associate learning (Bower & Bolton, in press), serial learning (Bower & Winzenz, 1969), and free-recall (Mandler, 1967). While there are many approaches to the study of organization and memory, one of the most productive to date has been the free-recall paradigm. In free-recall, the subject is presented with a series of items during an "input phase", and is asked to recall as many of the items as possible in any order during an "output phase". Presentation of the items may be simultaneous or successive, but is usually successive. There may be just one input and one output phase, or several input and output phases may be combined in an alternating or other type of sequence. Single words are usually the items of concern, although other types of material such as syllables, letters, digits, and geometric figures are used. The thing that is "free" about free-recall is the order in which the subject may recall

the items during the output phase. Interestingly, certain regularities appear in the ordering of items during output that were not present in the ordering of items during input. It is these discrepancies between the order in which items have been presented and the order in which they are recalled that have provided evidence for organizational processes in memory.

Tulving (1968) has distinguished between two types of organization in free recall. Primary organization refers to consistent discrepancies between the order in which items are presented and the order in which they are recalled, independent of the subject's familiarity with the items. An example of this type or organization would be the recency effect in which the subject tends to recall items presented in the terminal positions of the list, prior to items from other positions, regardless of the characteristics of these items (Murdock, 1962). Secondary organization refers to consistent discrepancies between the order in which items are presented and the order in which they are recalled that are determined by relations among the items influenced by intra-or extra-experimental factors. An example of this type or organization would be the influence of a subject's extra-experimental verbal habits that lead to the contiguous recall of words from the same conceptual category. To date, research has tended to focus on secondary organization, and Shuell (1969) has recently reviewed the literature on the two basic approaches to secondary organization; clustering and subjective organization.

Clustering refers to the tendency of items which are related to one another either categorically or associatively to be recalled together, even though these items were not contiguous during presentation. This discrepancy

between the order in which items were presented and the order in which they are recalled is presumed to represent the subject's tendency to organize his recall on the basis of extra-experimental categorial or associative relationships. A large number of studies have been concerned with this tendency of related items to cluster during free-recall. The bulk of the studies have investigated categorical clustering in which the stimulus list is composed of words from mutually exclusive conceptual categories such as animals and furniture (Bousfield, 1953; Tulving & Pearlstone, 1966). Other studies have investigated associative clustering in which the list is composed of associatively related words from different conceptual categories (Jenkins & Russell, 1952; Deese, 1959; 1960). In general, these studies indicate that clustering on the basis of categorical or associative relationships occurs at above chance level, and increases in clustering are accompanied by increases in amount of recall.

It is important to note that the clustering measures of organization typically use experimenter defined relationships. That is, the stimulus list is composed of words that the experimenter has chosen to be more or less related to one another in some way. Mandler (1967) and Tulving (1968) have pointed out that such a procedure raises two fundamental difficulties. First, the subject may fail to discover the relationships built into the list by the experimenter. Second, even if the subject does discover the relationships built into the list, he may fail to use them as the basis of his organization. In both cases, idiosyncratic organization may be present in the recall. However, since idiosyncratic clusters are typically not measured in clustering experiments, organization is likely to be underestimated when only experimenter defined relationships are examined.

Measures of subjective organization differ from the clustering approach in that organization of the list is not predetermined by the experimenter. Rather the focus is on the idiosyncratic organization of the subject. Typically, the stimulus list is composed of words that are "unrelated" in the sense that the experimenter has not attempted to choose words which are related categorically or associatively.

Tulving (1962 a) has developed a measure of subjective organization based on the extent to which the subject recalls pairs of words in the same order on two successive trials. He has theorized that when two or more items occur in temporal contiguity during different output phases they represent an organizational unit formed by the subject. Tulving (1962 a; 1964) has shown that the tendency to recall words together as a unit increases systematically over trials, and is positively correlated with the amount of correct recall.

Other investigators have developed different approaches to the measurement of subjective organization (Mandler, 1967; Seibel, 1964). For example, Mandler (1967) asked subjects to sort "unrelated" words into categories of their own choosing prior to free-recall. Typically, the subjects were asked to use from two to seven categories, and the same words were sorted on successive trials until two identical sorts had been achieved. Free recall followed the criterion sorting trial. Such a procedure has the advantage of providing information about the subject's organization of the input list prior to recall, and the relationship between organization during input and performance. The findings revealed a strong relationship between the number of classificatory cateogries used by the subjects and the number of items recalled during free-recall (Median r=.70).

A major theoretical position that has emerged from the free-recall data has been the suggestion, notably by Mandler (1967) and Tulving (1968), that recall is dependent upon organization. There is considerable evidence to support this view, although it is not unequivocal. One of the most significant difficulties is that most measures of organization are output phenomena from which we infer some sort of organizational process on the part of the subject. Thus, perhaps the best support for this theoretical position comes from Mandler's (1967) studies in which the measure of organization was independent of recall. In any event, such a theoretical position suggests that the locus of adult age differences in memory may be in organization processes.

Adult Age Differences

Let us now turn to a selective review of studies concerned with adult age differences. These studies have generally reported little age-related memory loss on tasks that do not exceed the span of immediate memory (Bromley 1958; Gilbert, 1941). On the other hand, tasks exceeding the span of immediate memory, or introducing interference in addition to the recall process, have usually revealed a decrement in performance with increasing age (Friedman, 1966; Talland, 1965; 1967; Taub, 1966; 1968).

The distinction between tasks which exceed and do not exceed the span of immediate memory can perhaps be clarified by mentioning various two-process models of memory which have been proposed. These models disagree over whether the two processes involve two memory storage systems (Atkinson & Shiffrin, 1968; Craik, 1968 a; 1968 b; Glanzer & Cunitz, 1966), or one memory store but two retrieval processes (Tulving, 1968). However, basic to most of the models are the concepts of a primary or short term memory and a secondary or long term memory. Primary or short term memory is conceptualized as having a very limited capacity, and is based on primary

organizational processes such as the list position of the words. Secondary, or long term memory is conceptualized as having a much larger capacity, and is based on secondary organizational processes such as the denotative meaning of the words.

Craik (1968 a; 1968 b) has proposed that primary memory is little affected by increasing adult age, but that there are age-related deficits in secondary memory. This proposal has received support (Craik, 1968 a; 1968 b). Estimates of primary memory showed little decline with increasing age, while estimates of secondary memory declined significantly with increasing age.

Other evidence supports the suggestion of an age-related decrement in the organizational processes of memory. A number of studies have indicated that older individuals exhibit an increasing recall deficit, relative to younger individuals, as the stimulus material becomes more amenable to organization. Amenability to organization has been manipulated in a variety of ways including native versus foreign language items (Heron & Craik, 1964) order of approximation to English text (Craik and Masani, 1967), vocabulary size (Craik, 1968 a; 1968 b), and degree of conceptual relatedness (Laurence, 1967 a). For example, Craik and Masani (1967) varied amenability to coding by manipulating order of approximation to English. Lists of 10 and 30 words at 0, 1st, 3rd, and 5th orders of approximation to English, and lists of standard English text were used. Different age effects were found for subjects with high and low vocabulary scores. In the case of subjects with high vocabulary scores, there were no significant age differences in the recall of the different types of lists although recall increased as the list material went from zero order approximation to text. In the case of

subjects with low vocabulary scores, the relative difference in recall between the younger and older subjects increased as the order of approximation to English went from zero order to text.

Thus, these studies infer the presence of age-related differences in the organizational processes of memory since there is a greater decrement in recall performance with increasing age as the to-be-recalled material becomes more amenable to organization.

The presence of an age-related decrement in the organizational processes of memory has also been suggested by studies which have manipulated the conditions of free-recall, rather than the stimulus materials. For example, Hultsch (1969) presented a multitrial free-recall task to three groups of men aged 16-19, 30-39, and 45-54. Organization was manipulated by different instructional conditions; standard free-recall instructions, instructions to organize recalled words without mention of specific organizational methods, and instructions to organize recalled words alphabetically. Different results were found for subjects classified as having high-and-low-verbal-facility on the basis of vocabulary test scores. In the case of the high-verbal facility individuals, no significant age differences were detected at all. In the case of the low-verbal-facility individuals, there was a significant decrement in recall performance for the 30-39 and 45-54 year old subjects under the standard free-recall instructions and non-specific organizational instructions. However, under the alphabetical instructions there were no significant age differences in recall performance. These results suggest a production deficiency explanation of the poorer recall performance of certain types of older individuals which may be mediated by organizational variables. Thus, under the standard free-recall and non-

specific organizational conditions the older low-verbal-facility subjects may have been less able or less willing than the younger subjects to organize the material for retrieval. However, providing the subjects with an organizational strategy based on an overlearned code resulted in a reduction of age differences in performance.

A second study (Hultsch, in press) was designed to confirm the production deficiency hypothesis by determining whether the opportunity to organize the stimulus material prior to recall is a significant age-related variable. The experiment was also designed to examine characteristics of the organization of the input list prior to free-recall at different ages. This study used Mandler's (1967) procedure in which subjects are required to categorize words to a criterion of two identical sorts prior to free-recall. Such a procedure has the advantage of providing information about the subject's organization of the input list prior to recall, and the relationship between organization during input and performance. Women from three age ranges (20-29, 40-49, 60-69) performed the task. The opportunity for organization of the input list prior to recall was manipulated experimentally. Half of the subjects at each age level were instructed to categorize the words into from two to seven categories to a criterion of two successive identical sorts prior to free-recall. The other half of the subjects were not allowed to physically sort the words into categories. The non-sorting subjects were randomly paired with a sorting subject. They inspected the words, one at a time, for the same number of trials as taken by their sorting partner to reach criterion. The sorting and non-sorting conditions were designed to maximize and minimize opportunity for the subjects to organize the material in ways that were meaningful to him, while

equating the number of input trials prior to recall.

The free-recall results supported a production deficiency explanation. Under the sorting condition, the 20-29 year old subjects recalled significantly more words than the 60-69 year old subjects, but there was no significant difference between the 20-29 and 40-49 year old subjects, nor between the 40-49 and 60-69 year old subjects. However, under the non-sorting condition, the 20-29 year old subjects recalled significantly more words than both the 40-49 and 60-69 year old subjects, but there was no significant difference between the two older groups. Thus, the older subjects exhibited less of a recall deficit under conditions that maximized the possibility for meaningful organization.

The experiment was also designed to examine the characteristics of the organization of the input list prior to free-recall. Contrary to expectation, no significant differences were detected among the three age groups of the sorting condition on a number of measures of free-classification performance. Thus, while age differences in recall performance were clearly evident, these could not be related to input organization, at least as it was measured.

In summary, research that has manipulated the amenability of the stimulus material to organization, or the conditions of recall has suggested the possibility of an age-related deficit in the organizational processes of memory.

It is interesting to note that few studies of adult age differences in free-recall have included measures of secondary organization. Two studies have used Tulving's (1962 a) measure of subjective organization (Hultsch, 1968; Laurence, 1966), and one study has used a measure of category clustering (Hultsch, in press). However, while these studies have found significant

age differences in recall performance, they have failed to find any significant age differences in these measures of secondary organization. Since it has been suggested that recall is dependent on organization, such a finding is puzzling. Laurence (1966) has suggested one possible explanation for the failure of her data to show adult age differences on Tulving's (1962 a) measure of subjective organization. It will be recalled that Tulving's measure is based on the extent to which the subject recalls pairs of words in the same order over trials. Such behavior could be defined as rigid. Thus, Laurence (1966) has suggested that the older subject's tendency toward rigid behavior may be responsible for inflating his subjective organization score.

A more likely explanation stems from the fact that most measures of secondary organization are nonspecific output phenomena from which we infer some sort of organizational process on the part of the subject. The lack of independence of most measures of organization from recall, and their nonspecific nature, results in a number of possible sources of error. Tulving's (1962 a) measure used by Laurence (1966) and Hultsch (1968) illustrates the problem. To the extent that the subject's idiosyncratic clusters are larger than pairs, and vary in order of recall within the cluster from trial to trial, organization will be underestimated by this measure. For example, a subject may recall an idiosyncratic cluster containing four items ordered A, B, C, D on trial one. If this cluster is recalled A, B, C, D on trial 2, his organization score will increase, but if it is recalled C, B, D, A, it will not increase at all. Further, if younger subjects tend to form larger clusters than older subjects, the measure would underestimate the organization of the younger subjects to a greater extent than that of the older subjects.

Such difficulties illustrate the need for measures of organization that are independent of recall, and that specify the nature of organization at the time of input and the relationship between input and output organization and performance.

Concluding Comments

While research has indicated the possibility of an age-related decrement in the organizational processes of memory, at least for certain individuals, a number of questions remain. Two come to mind immediately. First, what is the specific nature of the organizational deficit? Second, what are the antecedents that account for the deficit?

In approaching such questions a sketch of a rough model may be helpful. Perhaps the simplest analysis of memory is to divide the process into two parts; storage and retrieval (Melton, 1963). One can then ask whether the age-related decrement in performance on free-recall tasks represents a problem of storage or retrieval. This is not a new question. Schonfield (1965; 1967) and Schonfield and Robertson (1966) have argued that memory loss with age represents a decreased ability to retrieve items from storage rather than a deficiency in the storage system itself. This conclusion was based on findings that indicated a deficit in recall scores with increasing age, but no age-related deficit in recognition scores. While it has been argued that a comparison of recall and recognition scores cannot answer a storage versus retrieval question (McNulty & Caird, 1966; 1967), it seems to be a question worth examining.

Certain experimental data suggest the heuristic usefulness of the distinction between storage and retrieval processes. In general, these point out that the subject usually knows much more than he can recall. This can

be shown by comparing unaided recall to recognition (Schonfield & Robertson, 1966), by comparing unaided recall to cued recall (Tulving & Pearlstone, 1966), and by examining recall from successive output phases without intervening input phases (Tulving, 1967). Findings such as these have led Tulving (1967; 1968) to suggest that the limitation of memory lies primarily in retrieval rather than in storage. It is argued that the availibility of individual items at the time of recall depends on the degree and nature of the organization of the items at the time of input, and the availibility of this organization at recall (Tulving, 1967; 1968; Tulving & Osler, 1968; Tulving & Pearlstone, 1966). Thus, according to this view, organization represents a retrieval plan or rule to provide a set of cues for the words in the list at recall.

Such a model suggests that the limitation of memory with increasing age lies primarily in retrieval rather than storage. There is some experimental support for this hypothesis. Craik and Masani (1969) presented word lists of several orders of approximation to English to younger and older subjects. Total recall was broken down into the number of words per chunk, and the number of chunks recalled according to a method described by Tulving and Patkau (1962). The number of words per chunk was taken to refect storage processes, while the number of chunks recalled was taken to reflect retrieval processes. The results indicated an age related decrement in retrieval (number of chunks recalled), but not in storage processes (number of words per chunk).

The model also suggests at least two possible sources of adult age differences in retrieval processes: (1) differences in the quantity and quality of the information contained in the retrieval plan, and (2) difference

in the availability of the retrieval plan at recall.

First, let us examine the possibility of differences in the quantity and quality of organization. On the one hand, there may simply be adult age differences in the quantity of information contained in the retrieval plan. That is, younger subjects may be more willing or able to relate larger numbers of the list items to one another than are older subjects. Such a hypothesis would predict adult age differences on measures such as clustering and subjective organization which compute the amount of organization present in recall. Studies which have computed these measures (Hultsch, 1968; in press; Laurence, 1966) have failed to find significant age differences However, it has already been pointed out that most of these measures are open to a number of sources of error, primarily because of their lack of independence from recall and non-specific nature. Thus, such findings do not rule out the possibility of adult age differences in quantity of organization.

On the other hand, there may be adult age differences in the quality of organization. The various measures of organization which have been developed simply indicate that some form of grouping or clustering has taken place. While grouping or clustering per se is a common cognitive strategy, it probably represents the simplest of retrieval plans. Clearly, other strategies must be involved if the person is to recall most of the words in the list. That is, even if the subject establishes stable clusters of some type, he still requires a method of retrieving these clusters from memory and moving from one cluster to the next during recall. Bower (1970) has pointed out a number of possible retrieval strategies in addition to clustering First, one cluster may be directly associated with another, although this may be relatively difficult depending on the material. Second, the retrieval

scheme may provide a set of well-known or overlearned cues to associate with each word or subjective group in the list. For example, the use of the alphabet as a mnemonic device represents this type of strategy. The list words are associated with their first letter so a means airplane, b means baby, c means cat, and so forth (Earhard, 1967; Hultsch, 1969; Tulving, 1962 b). Third, semantic categories may form a hierarchical retrieval plan. Items are categorized under semantic features in a first-order retrieval plan. Then, these semantic features are categorized into broader but fewer super-ordinate categories, and so forth, thus generating a hierarchy of nested sets (Bower, Clark, Winzenz, & Lesgold, 1969; Mandler, 1967). The point is that there are qualatative differences in organizational processes and these may be involved in adult age differences in memory. There are few data which examine such qualatitive differences.

A second possible source of adult age differences in memory is the availability of organization at recall. Obviously, a retrieval plan must be retained until recall if it is to be effective. It has been shown that younger subjects fail to retain all of these cues (Cohen, 1966), and that performance can be increased by reinstating cues at the time of recall (Tulving & Osler, 1968; Tulving & Pearlstone, 1966). It is possible that older subjects simply do not retain as many of the retrieval cues as younger subjects. There is one study which suggests that this may be the case. Laurence (1967 b) presented younger and older subjects with a single trial free-recall task consisting of a 36 word list composed of six words in each of six different categories. At recall, half of the subjects in each age group received a cue card containing the six category names, while the

other half did not. The results indicated a significant age-related decrement in recall under the non-cued condition of recall, but not under the cued condition of recall.

Thus, there is evidence to suggest the presence of an age-related decrement in the organizational processes of memory. In addition, there is evidence to suggest that the limitation of memory with increasing adult age lies primarily in retrieval rather than storage. I have suggested that the next step is to specify the nature of this retrieval deficit. At present, there is little information that adequately approaches the problem. Of course, such a suggestion does not even approach the vital question of antecedents that I mentioned before. However, it seemed that a discussion of antecedents of differences, before one knows what the differences are, is a bit presumptious. Thus, I will refrain.

In closing, I make four brief points, some of which are in the nature of sermonizing on my part.

First, while I have consistently referred to age differences in this paper, the possibility of cohort differences should not be overlooked (Baltes, 1968; Schaie, 1965). Different cohorts of individuals may use different organizational strategies on memory tasks because of shifts in educational training practices, for example.

Second, when focusing on age differences, it is interesting to note that a number of studies have found decrements in memory performance at relatively early age levels (Hultsch, 1969; in press; Talland, 1968). Talland (1968) has noted that the loss of capacity in recall does not occur in a linear fashion with increasing age. Rather, there seems to be a decrement in performance at about age 40, and again at about age 60. Findings such

as these underscore the need for studying cognitive processes throughout adulthood, rather than confining investigations to comparisons of "young" and "old" individuals where "young" refers to the 20s and "old" refers to the 60s, 70s, and 80s.

Third, one of the most effective developmental research strategies is to indicate the presence of Age X Experimental Treatment interactions. Rather than focusing on absolute age differences, which are expected anyway, the focus is on relative age differences produced by the manipulation of one or more variables. However, it is apparent that a given experimental treatment does not have a uniform effect on all subjects. For example, several studies have found different age effects for subjects scoring high and low on vocabulary tests (Craik, 1968; Hultsch, 1969). Such findings suggest the need for combining age, individual difference and situational variables into Age X Aptitude X Treatment designs.

Finally, it is obvious that problems of adult age differences in learning and memory are multivariate ones. At some point, we must ask ourselves not only what variables account for significant differences, but how much variance each of these variables accounts for if they are combined in a prediction equation.

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FOOTNOTES

[1]An earlier version of this paper was presented at the Division 20 Symposium on Memory and Thinking, American Psychological Association, Miami Beach, Florida, September 3, 1970.

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SUMMARY

The research reviewed illustrates how organizational processes (grouping and relating) influence memory in general, and adult age differences in memory in particular. While there are many approaches to the study of organization and memory, one of the most productive to date has been the free recall paradigm. Specifically, the free recall data have indicated that the subject, by one means or another, segments the learning material into integrated groups which become his functional recall units. Thus, a major theoretical position that has emerged has been the suggestion that recall is dependent on organization. Such a theoretical position has led to the hypothesis that the locus of adult age difference in memory may be in organizational processes. The research reviewed suggests that there is evidence of an age-related decrement in the organizational process of memory. One group of studies has indicated a greater recall deficit with increasing age as to to-be-recalled material becomes more amenable to organization. A second group of studies has suggested a production deficiency explanation of the poorer recall of older individuals. These studies have found age differences in performance under standard free recall conditions, but no age differences under conditions that provide organizational strategies for the subject, or increased opportunities for meaningful organization. It was noted that few studies of adult age differences in free recall have included measures of organization such as clustering or subjective organization. Studies that have included such measures have failed to find significant age differences on them, although differences in recall performance have been clearly evident. It was suggested that this discrepancy may be a function of the tendency of the measures to underestimate organization. While research has indicated the possibility of an age-related decrement in the organizational processes of memory, questions concerning the specific nature of the deficit and antecedents that

account for it still remain. In approaching these questions, a rough model was developed. The model suggested a division of the memory process into two parts; storage and retrieval. It further suggested that the limitation of memory lies primarily in retrieval rather than storage. The availability of individual item at recall was seen as a function of the degree and nature of the organization of the items at the time of input, and the availability of this organization at recall. Applied to adult age differences, the model suggested several possible sources of the recall deficit. In particular, it suggested the possibility of adult age differences in the quantity and quality of the information contained in the retrieval plan, and the availability of the plan at recall.